^{40}AR/^{39}AR IMPACT AGES AND TIME-TEMPERATURE ARGON DIFFUSION HISTORY OF THE BUNBURRA ROCKHOLE ANOMALOUS BASALTIC ACHONDRITE.

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The Bunburra Rockhole meteorite [1] is a brecciated anomalous basaltic achondrite containing coarse-, medium- and fine-grained lithologies. Petrographic observations constrain the limited shock pressure to between ca. 10 GPa and 20 GPa. We carried out nine ^{40}Ar/^{39}Ar step-heating experiments on distinct single-grain fragments extracted from the coarse and fine lithologies. We obtained six plateau ages and three mini-plateau ages. These ages fall into two internally concordant populations with mean ages of 3640 ± 21 Ma (n=7; P=0.53) and 3544 ± 26 Ma (n=2; P=0.54), respectively. Based on these results, additional ^{40}Ar/^{39}Ar data of fusion crust fragments, argon diffusion modeling, and petrographic observations, we conclude that the principal components of the Bunburra Rockhole basaltic achondrite are from a melt rock formed at ~3.64 Ga by a medium to large impact event. The data imply this impact generated high enough energy to completely melt the basaltic target rock and reset the Ar systematics, but only partially reset the Pb-Pb age. We also conclude that a complete ^{40}Ar* resetting of pyroxene and plagioclase at this time could not have been achieved at solid-state conditions. Comparison with a terrestrial analogue (Lonar crater; [2]) shows that the time-temperature conditions required to purge a basaltic melt rock from inherited 40Ar* upon impact are relatively easy to achieve. Ar data also suggest that a second medium-size impact event occurred on a neighboring part of the same target rock at ~3.54 Ga. Concordant low-temperature step ages of the nine aliquots suggest that, at ~3.42 Ga, a third smaller impact excavated parts of the ~3.64 Ga and ~3.54 Ga melt rocks and brought the fragments together. The lack of significant impact activity after 3.5 Ga, as recorded by the Bunburra Rockhole suggest that (1) either the meteorite was ejected in a small secondary parent body where it resided untouched by large impacts, or (2) it was covered by a porous heat-absorbing regolith blanket which, when combined with the diminishing frequency of large impacts in the solar system, protected Bunburra from subsequent major heating events. Finally we note that the total (K/Ar) resetting impact event history recorded by some of the brecciated eucrites (peak at 3.8-3.5 Ga [3,4]) is similar to the large impact history recorded by the Bunburra Rockhole parent body (ca. 3.64-3.54 Ga; this study) and could indicate a similar position in the asteroid belt at that time.

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